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CHAPTER SIX:

QUALITY ASSURANCE

Quality Assurance specifications require that the acceptance of material be the responsibility of INDOT. The specification addresses specifically:

1. The units of material quantity used for acceptance.
2. The process of obtaining random samples.
3. What mixture characteristics are considered of critical importance.
4. At what test values can the mixture be accepted at 100% payment.
5. At what levels can the mixture serve at less than design intent and still be of value, and be paid at some adjusted price.
6. At what level should rejection of the material be considered.
7. An appeal procedure for resolving disagreements in QC and QA test results.

This chapter discusses procedures and requirements for sampling, testing, and payment of superstructure concrete.

SUBLOTS AND LOTS

Quality Assurance specifications consider a subplot as typically 50.0 yd³ as measured against the plan quantity for each mix design of superstructure concrete. A partial subplot of 15.0 yd³ or less will be considered as part of the previous subplot and a partial subplot greater than 15.0 yd³ will be considered an individual subplot.

A lot will typically consist of three sublots or 150.0 yd³ of planned quantity of superstructure concrete for each mix design. If there is only one subplot in an incomplete lot then the subplot will be included in the previous lot. If there are two sublots in an incomplete lot then the quantity of material will be considered a lot. Therefore, a lot may contain two, three or four sublots.

If the superstructure concrete is placed at several locations on one contract, such as one bridge to another bridge or one phase to another phase, then the sublots will be determined in the order that the material was placed.

RANDOM SAMPLING

Sampling of material for acceptance testing is done by INDOT on a random basis using ITM 802. A random cubic yard of superstructure concrete within a subplot is determined and the location on the bridge deck of the random quantity is established. The random locations are not given to the Contractor so that there will be no possible influence on the production operations.

Random Numbers

A table of Random Numbers from ITM 802 (Figure 6.1) is used to determine the random quantity. The numbers occur in this table without aim or reason and are in no particular sequence. Therefore, samples obtained by the use of this table are truly random or chance, and eliminate any bias in obtaining samples.

To use this table to determine the random cubic yard of concrete to sample, select without looking one block in the table. After selecting the block the top left number in the block is the first random number used. This number will be the beginning number for the project. Proceed down the column for additional numbers and proceed to the top of the next column on the right when the bottom of the column is reached. When the bottom of the last column on the right is reached, proceed to the top of the column at the left. If all numbers in the table are used before the project is completed select a new starting number and proceed in the same manner.

Sample Location

The location where the random sample is obtained is determined by calculating the average depth of the bridge deck concrete, the random quantity within the subplot, the length of each subplot, and the random location within the subplot. The QC/QA superstructure concrete item quantities and locations are detailed in the plans and often include bridge deck and several non-bridge deck items such as wing walls, end bent diaphragms, and pier diaphragms. The width and depth of the bridge deck concrete, length of each pour, and sequence of pours are all information items that may also be obtained from the plans and are used for location of the random sample.

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.040	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.389	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.777	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.701	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.876	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.777	0.491	0.523	0.665	0.919	0.246
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.658	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.702	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

FIGURE 6.1 - RANDOM NUMBERS

The procedure for determining the random sample location is as follows:

1. Determine the number of lots for each concrete mix design by dividing the total quantity by 150.0 yd³ and rounding as follows:
 - a. If the resulting decimal portion is less than or equal to 0.434 then round the result down to the nearest whole number. The last lot will contain 3 or 4 sublots.
 - b. If the resulting decimal portion is greater than 0.434 then round the result up to the nearest whole number. The last lot will be less than the standard quantity, consist of 2 or 3 sublots, and likely will have one subplot of partial size.
2. Determine the average depth of bridge deck concrete for each phase on the project. The depth of concrete is calculated as follows:

$$\text{Avg. Bridge Deck Depth (ft)} = \frac{\text{Phase Quantity (yd}^3\text{)} \times 27}{\text{Width (ft)} \times \text{Length (ft)}}$$

where:

Width = Bridge Deck Width

Length = Bridge Deck Length

3. Determine the subplot size, the cumulative quantity of the phase or structure, the remainder quantity in the phase or structure, and the carry over quantity to the next phase or structure.
4. Select a random number
5. Determine the random quantity within the subplot by multiplying the subplot size by the random number.
6. Determine the random distance from the start of the phase or structure to the random sample location (nearest 0.1 ft).
7. Determine the subplot location to the nearest 0.01 ft in relation to the beginning of the lot. The beginning of lot 1 subplot 1 would be considered 0. The end of subplot 1 should be 0 plus the length of bridge deck subplot quantity. Each subsequent subplot would begin with the end of the previous subplot.

The distance to the random sample location is measured from the beginning of the QC/QA superstructure concrete on the bridge deck and along the centerline of the bridge deck pour. Distances from the beginning of the QC/QA superstructure concrete, such as each 5 ft, should be marked on the bridge deck forms to aid in determining the random location. If a subplot is not completed on the phase or structure, and there is another phase or structure on the project, then the subplot shall be completed on the other phase or structure.

Example (Figures 6.2 - 6.6)

One Structure - Two Passes

One Concrete Mix Design

Total QC/QA Superstructure Concrete = 512.5 yd³

Phase I Quantity (z) = 213.2 yd³

Phase II Quantity (z) = 299.3 yd³

$$\text{Number of Lots} = \frac{512.5}{150.0} = 3.417$$

There will be 3 lots with the last lot containing 4 sublots as follows:

CMD 1 of 1			
Sublot Nos.	LOTS		
	1	2	3
1	50.0	50.0	50.0
2	50.0	50.0	50.0
3	50.0	50.0	50.0
4			62.5
Σ	150.0	150.0	212.5

The last quantity of 12.5 yd³ in Lot 3 of Phase II is less than 15.0 yd³ and is therefore considered part of the previous subplot of 50.0 yd³. Since there is only one subplot at the completion of the structure, the 62.5 yd³ subplot (50.0 + 12.5) is included in the previous lot.

Phase I

$$\begin{aligned}\text{Bridge Deck Length (l)} &= 220.80 \text{ ft} \\ \text{Bridge Deck Width (w)} &= 35.52 \text{ ft} \\ \text{Avg. Bridge Deck Depth (d)} &= \frac{213.2 \times 27}{220.80 \times 35.52} \\ &= 0.73 \text{ ft}\end{aligned}$$

Phase II

$$\begin{aligned}\text{Bridge Deck Length (l)} &= 220.80 \text{ ft} \\ \text{Bridge Deck Width (w)} &= 47.57 \text{ ft} \\ \text{Avg. Bridge Deck Depth (d)} &= \frac{310.5 \times 27}{220.80 \times 47.57} \\ &= 0.80 \text{ ft}\end{aligned}$$

Lot 1 Sublot 1 (Phase I)

$$\begin{aligned}\text{Sublot Size} &= 50.0 \text{ yd}^3 \\ \text{Cumulative Quantity of Phase} &= 0+50 \\ &= 50 \text{ yd}^3 \\ \text{Remainder Quantity of Phase} &= 213.2-50.0 \\ &= 163.2 \text{ yd}^3 \\ \text{Random Number} &= 0.566 \\ \text{Random Quantity Within Sublot} &= 50.0 \times 0.566 \\ &= 28.3 \text{ yd}^3 \\ \text{Random Dist. From Start of Phase} &= \frac{(28.3-50.0+50.0)27}{35.52 \times 0.73} \\ &= 29.5 \text{ ft} \\ \text{Beginning of Sublot 1} &= 0 \text{ ft} \\ \text{End of Sublot 1} &= \frac{27 \times 50.0}{35.52 \times 0.73} \\ &= 52.06 \text{ ft}\end{aligned}$$

Therefore, the sample from Lot 1 Sublot 1 will be obtained at 28.3 yd³ which is located 29.5 ft from the start of Phase I.

Additional sample locations are indicated in Figure 6.3 - 6.6. (Notice that Lot 2 Sublot 2 begins in Phase I and ends in Phase II and the sample is required to be obtained in Phase II).

Worksheet for Planning Lot & Sublot Distribution of QC/QA Superstructure Concrete in English Units

Contract No. B-25280 Total Plan Quantity 523.7 yd³ Number of CMD's required 1

First CMD to be used, of			Second CMD to be used, of		
Construction Phase	Structure No.	Plan Quantity yd ³	Construction Phase	Structure No.	Plan Quantity yd ³
I		213.2			
II		299.3			

$$\Sigma = \frac{512.5 \text{ yd}^3}{\div 150.0 \text{ yd}^3} = 3.417$$

$$\Sigma = \frac{\text{ } \text{yd}^3}{\div 150.0 \text{ yd}^3} = \text{ }$$

1. If decimal portion is less than 0.434, round the result down to nearest whole number to determine the number of Lots. The last Lot of a CMD will contain 3 or 4 Sublots
2. If decimal portion is equal to or greater than 0.434, round the result up to the nearest whole number to determine the number of Lots. The last Lot of a CMD will be less than the standard quantity, consist of 2 or 3 Sublots, and likely will have one Sublot of partial size.
3. An individual Sublot cannot contain less than 15.1 yd³ or more than 65.0 yd³.
4. The last Lot for a CMD is required to have at least 2 Sublots, but never more than 4 Sublots.

CMD <u>1</u> of <u>1</u>										
Sublot Nos.	Quantities (yd ³) within Lot Nos.									
	1	2	3	4	5	6	7	8	9	10
1	50.0	50.0	50.0							
2	50.0	50.0	50.0							
3	50.0	50.0	50.0							
4			62.5							
Σ	150.0	150.0	212.5							

CMD <u> </u> of <u> </u>										
Sublot Nos.	Quantities (yd ³) within Lot Nos.									
	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
Σ										

FIGURE 6.2

**INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TEST DIVISION**

**RANDOM SAMPLING FOR SUPERSTRUCTURE CONCRETE
(ENGLISH UNITS)**

Contract No. B-25280 Str. No. 227-89-45308 Construction Phase I CMD 1 of 1

QC/QA Superstructure Quantity for Phase (z) 213.2 yd³

Phase Construction Dimensions: Length (l) 220.80 ft, Width (w) 35.52 ft

Average Depth (d) = $\frac{z \times 27}{l \times w}$ 0.73 ft

Lot No. 1 Lot Size 150.0 yd³ Number of Sublots 3

Sublot No.	Sublot Size (yd ³)	Cumulative Quantity of Ph/Str (yd ³)	Remainder Quantity (yd ³)	Random No.	Random Quantity Within Sublot (yd ³)	Random Distance From Start of Ph/Str (ft)	Sublot Location	
							Begin (ft)	End (ft)
	A	B	z-B	C	D = AxC	$\frac{(D-A+B)27}{w \times d}$		$\frac{27B}{w \times d}$
1	50.0	50.0	163.2	0.566	28.3	29.5	0	52.06
2	50.0	100.0	113.2	0.901	45.1	99.0	52.06	104.13
3	50.0	150.0	63.2	0.470	23.5	128.6	104.13	156.19
4								

* Sublot information that carries over to the next construction phase or structure placement.

** Acceptance sample location will be obtained during next construction phase or structure placement.

FIGURE 6.3

**INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TEST DIVISION**

**RANDOM SAMPLING FOR SUPERSTRUCTURE CONCRETE
(ENGLISH UNITS)**

Contract No. B-25280 Str. No. 227-89-45308 Construction Phase I CMD 1 of 1

QC/QA Superstructure Quantity for Phase (z) 213.2 yd³

Phase Construction Dimensions: Length (l) 220.80 ft, Width (w) 35.52 ft

Average Depth (d) = $\frac{z \times 27}{l \times w}$ 0.73 ft

Lot No. 2 Lot Size 150.0 yd³ Number of Sublots 3

Sublot No.	Sublot Size (yd ³)	Cumulative Quantity of Ph/Str (yd ³)	Remainder Quantity (yd ³)	Random No.	Random Quantity Within Sublot (yd ³)	Random Distance From Start of Ph/Str (ft)	Sublot Location	
							Begin (ft)	End (ft)
	A	B	z-B	C	D = AxC	$\frac{(D-A+B)27}{w \times d}$		$\frac{27B}{w \times d}$
1	50.0	200.0	13.2	0.068	3.4	159.7	156.19	208.26
2	50.0	250.0	-36.8*	0.713	35.7**	**	208.26	---
3								
4								

* Sublot information that carries over to the next construction phase or structure placement.

** Acceptance sample location will be obtained during next construction phase or structure placement.

Sublot 2 Sample will be obtained in Phase II

FIGURE 6.4

**INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TEST DIVISION**

**RANDOM SAMPLING FOR SUPERSTRUCTURE CONCRETE
(ENGLISH UNITS)**

Contract No. B-25280 Str. No. 227-89-45308 Construction Phase II CMD 1 of 1

QC/QA Superstructure Quantity for Phase (z) 299.3 yd³

Phase Construction Dimensions: Length (l) 220.80 ft, Width (w) 47.57 ft

Average Depth (d) = $\frac{z \times 27}{l \times w}$ 0.77 ft

Lot No. 2 Lot Size 150.0 yd³ Number of Sublots 3

Sublot No.	Sublot Size (yd ³)	Cumulative Quantity of Ph/Str (yd ³)	Remainder Quantity (yd ³)	Random No.	Random Quantity Within Sublot (yd ³)	Random Distance From Start of Ph/Str (ft)	Sublot Location	
							Begin (ft)	End (ft)
	A	B	z-B	C	D = $\frac{D-A+B}{A \times C}$	$\frac{(D-A+B)27}{w \times d}$		$\frac{27B}{w \times d}$
1								
2	50.0	36.8	262.5	0.713	35.7	16.6	Phase I 208.26	27.13
3	50.0	86.8	212.5	0.217	10.9	35.2	27.13	63.98
4								

* Sublot information that carries over to the next construction phase or structure placement.

** Acceptance sample location will be obtained during next construction phase or structure placement.

FIGURE 6.5

**INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TEST DIVISION**

**RANDOM SAMPLING FOR SUPERSTRUCTURE CONCRETE
(ENGLISH UNITS)**

Contract No. B-25280 Str. No. 227-89-45308 Construction Phase II CMD 1 of 1

QC/QA Superstructure Quantity for Phase (z) 299.3 yd³

Phase Construction Dimensions: Length (l) 220.80 ft, Width (w) 47.57 ft

Average Depth (d) = $\frac{z \times 27}{l \times w}$ 0.77 ft

Lot No. 3 Lot Size 223.7 yd³ Number of Sublots 4

Sublot No.	Sublot Size (yd ³)	Cumulative Quantity of Ph/Str (yd ³)	Remainder Quantity (yd ³)	Random No.	Random Quantity Within Sublot (yd ³)	Random Distance From Start of Ph/Str (ft)	Sublot Location	
							Begin (ft)	End (ft)
	A	B	z-B	C	D = AxC	$\frac{(D-A+B)27}{w \times d}$		$\frac{27B}{w \times d}$
1	50.0	136.8	162.5	0.307	15.4	75.33	63.98	100.84
2	50.0	186.8	112.5	0.879	44.0	133.27	100.84	137.69
3	50.0	236.8	62.5	0.755	37.8	165.56	137.69	174.55
4	62.5	299.3	0	0.125	7.8	180.30	174.55	220.62

* Sublot information that carries over to the next construction phase or structure placement.

** Acceptance sample location will be obtained during next construction phase or structure placement.

FIGURE 6.6

Sampling Procedure

The Contractor is required to provide an easily assessable means of obtaining concrete samples from the point of placement, and for transporting samples off the bridge deck for testing. Sampling for acceptance will be done by INDOT in accordance with AASHTO T 141.

ACCEPTANCE TESTING

The Contractor is required to submit a mix design and provide verification of the design by a Trial Batch Demonstration. The superstructure concrete properties shall meet the concrete parameters of the specifications prior to placement.

Acceptance testing results are shared with the Contractor. The air content, plastic unit weight, and compressive strength tests are measured for each subplot during concrete operations. The slump of the concrete is visually estimated.

Air Content and Unit Weight

The frequency of tests for the air content and unit weight is one series for each sample for each subplot. The air content will be determined in accordance with AASHTO T 152 when stone or gravel coarse aggregate is used in the concrete and AASHTO T 196 when slag coarse aggregate is used. The concrete material used to obtain the unit weight may be used to conduct the air content test.

A line parallel to the CMD Linear Equation will be established to represent a threshold limit where the water/cementitious ratio becomes 0.420. An individual subplot having a unit weight, for the air content measured, at or below the value representing the maximum allowable water/cementitious ratio, will have two additional cylinders cast. A test specimen will be extracted from each cylinder and tested by INDOT for resistance to chloride ion penetration in accordance with AASHTO T 277 at an age of 56 days. The test value will be the average of the two specimens.

Compressive Strength

The frequency of tests for the compressive strength will be one set of two cylinders for each subplot. The two cylinders will be tested at 28 days in accordance with AASHTO T 22 and the test values averaged to determine the subplot compressive strength.

The Contractor is required to provide sufficient containers filled with water saturated with calcium hydroxide at the work site for initial curing of compressive strength specimens. The cylinders are completely submerged in the saturated lime water at a temperature of 60 to 80°F for no less than 16 nor more than 48 hours. After the initial curing the cylinders are transported to the laboratory within 4 hours for additional curing, capping, and testing.

Slump

The slump of the concrete is visually estimated during production. If it is suspected that the slump is not within the allowable limits at the point of placement, the Contractor will be informed. The truck in question shall discontinue placement in the structure until a slump test is conducted to verify compliance. If the slump is outside compliance, the Contractor shall test the concrete for air content and unit weight. The truck shall not continue placement in the structure until quality control test results substantiate compliance.

PAY FACTORS

Pay factors are determined for air content, the range of air content, and compressive strength at 28 days. The range of air content is defined as the difference between the highest subplot air content and the lowest subplot air content within a lot.

Test values for each subplot are entered on the Superstructure Concrete Analysis for Quality Assurance form and averaged for the lot. Unit weight and the resistance to chloride ion penetration test values, if applicable, are also entered on this form. The averages for the lot are compared to the acceptance tolerances designated in the specifications for each property. Pay factors are assigned for each property in accordance with the specifications. An example of this procedure is shown in Figure 6.3.

The Superstructure Concrete Analysis for Quality Assurance form is completed by the PE/S and sent to the Contractor. Appeals, if necessary, are required to be submitted by the Contractor within five calendar days of receipt of this completed and signed form.

QUALITY ASSURANCE ADJUSTMENT

The pay factors based on air content, range of air content, and compressive strength at 28 days are used to calculate an adjusted amount of QC/QA superstructure concrete payment for each individual lot. The adjustment for each property is calculated as follows:

$$q_i = L_i \times U_m \times (PF_{ai} + PF_{ri} + PF_{ci} - 3.00)$$

where:

q_i = quality assurance adjustment for individual i^{th} lot

L_i = quantity for i^{th} lot

U_m = unit price for material, \$96/yd³ (\$125/m³)

PF_{ai} = pay factor for air content in i^{th} lot

PF_{ri} = pay factor for air content range in i^{th} lot

PF_{ci} = pay factor for compressive strength in i^{th} lot

The total quality assurance adjustment will be calculated as follows:

$$Q = \sum q_i$$

For lots $i=1$ to n

where:

Q = total quality assurance adjustment

i = individual lot

n = last lot

An example of this procedure is shown in Figure 6.7

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PE/PS**INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TESTS DIVISION****SUPERSTRUCTURE CONCRETE ANALYSIS FOR QUALITY ASSURANCE
(ENGLISH UNITS)**CONTRACT NO. _____ MIXTURE: w/o Silica Fume ~~w/Silica Fume~~ LOT NO. _____Threshold Equation for CMD at Max. Allowable W/C: $UW = -1.50$ (Air) + 149.3

PAY FACTORS							
Date	9/26/01	9/26/01	9/26/01				
Sublot Quantity (yd ³)	<u>50.0</u> Sublot 1	<u>50.0</u> Sublot 2	<u>50.0</u> Sublot 3	<u> </u> Sublot 4			
Properties					Average	Tolerance	Pay Factor PF
Air Content (%)	5.8	4.4	4.2		4.8	4.7 – 4.9	0.90
Threshold Unit Weight (lb/ft ³)	140.6	142.7	143.0				
Measured Unit Weight (lb/ft ³)	141.3	144.1	144.7				
Rapid CI Permeability (Coulombs)	-NA-	-NA-	-NA-				
28 Day Compressive Strength (psi)	4430	4865	5330		4875	4856 - 4891	0.92
Range of Air Content	5.8 – 4.2 = 1.6					0.0 – 2.9	1.00

Note: Insert asterisk (*) next to any failing Sublot Acceptance Sample result and submit copy of form to DMTE for processing as Failed Material.

QUALITY ASSURANCE ADJUSTMENT				
Lot Quantity L (yd ³)	Pay Factors			$q = L \times U_m \times (PF_a + PF_c + PF_r - 3.00)$ (\$)
	Air Content PF _a	Compressive Strength PF _c	Air Content Range PF _r	
150.0	0.90	0.92	1.00	- \$2592.00

$$U_m = \$96/\text{yd}^3$$

Project Engineer/ Project Supervisor Date

FIGURE 6.7

APPEALS

If the Contractor does not agree with the acceptance test results for a subplot of QC/QA superstructure concrete, an appeal may be submitted. The appeal shall satisfy the following criteria:

1. Appeals shall be submitted in writing to the PE/PS within five calendar days of receipt of INDOT's written results for the lot.
2. The submission shall contain quality control test data that equals or exceeds the number of tests required.
3. The difference between the acceptance test result and the nearest quality control test result shall be at least 0.5 percent for air content.
4. The difference between the acceptance test result and the nearest quality control test result shall be at least 100 psi for compressive strength at 28-days.

Cores shall be obtained by the Contractor at the location that most closely approximates the appropriate subplot acceptance sample location. The coring shall be completed within 30 days of acceptance of the appeal unless traffic restrictions prevent the coring. Cores shall be 3.75 or 4.00 inches in diameter and the Contractor shall fill all core holes with concrete within 24 hours of drilling.

Air Content Appeal for Sublot

For an air content appeal, four cores shall be taken from each subplot that qualifies and averaged. The hardened concrete air content will be determined in accordance with ITM 401 and converted to a value representing the air content in the plastic state.

The average value will be considered as the air content for the subplot in question. This value will be used to determine all subsequent actions involving the subplot and lot.

Compressive Strength Appeal for Sublot

For a 28-day compressive strength appeal, four cores shall be taken from each subplot that qualifies. Each core will be tested for compressive strength in accordance with AASHTO T 24. The four test values will be averaged for the subplot compressive strength value and this value will be used to determine all subsequent actions involving the subplot and lot.

FAILED MATERIALS

Sublot and lot values that are excessively out of tolerance are required to be submitted to INDOT for final adjudication. The test value criteria that will require such submittal include:

1. An individual subplot having an air content test value of less than 4.0 percent or more than 10.0 percent.
2. A resistance to chloride ion penetration test value greater than 4000 coulombs when this test is required for unit weight measures at or below the threshold limit.
3. An individual subplot having a 28-day compressive strength test value less than 5220 psi and 4400 psi for concrete with and without silica fume, respectively.
4. A lot having an air content test value average of 4.2 or less and 4.4 and less for concrete with and without silica fume, respectively.

A lot having an air content test value average of 10.0 or greater for concrete with or without silica fume.
5. A lot having a 28-day compressive strength test value average of 4675 psi or less and 5475 psi or less for concrete with and without silica fume, respectively.

As a minimum the Failed Materials Committee will consider the above-noted items for no additional payment adjustment, an increased payment adjustment to offset potential maintenance costs, additional payment to cover the cost of the investigation, no payment, or removal and replacement